



**PATENT**  
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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:

Wang et al.

Art Unit: 1765

Application No. 09/636,161

Examiner: Lynette T. Umez-Eronini

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For: **POLISHING SYSTEM AND  
METHOD OF ITS USE**

**PENDING CLAIMS AFTER AMENDMENTS  
MADE IN RESPONSE TO OFFICE ACTION DATED DECEMBER 20, 2001**

1. A system for polishing one or more layers of a multi-layer substrate that includes a first metal layer and a second layer comprising (i) a liquid carrier, (ii) at least one oxidizing agent, (iii) at least one polishing additive that increases the rate at which the system polishes at least one layer of the substrate, wherein the polishing additive is selected from the group consisting of pyrophosphates, condensed phosphates, phosphonic acids and salts thereof, amines, amino alcohols, amides, imines, imino acids, nitriles, nitros, thiols, thioesters, thioethers, carbothiolic acids, carbothionic acids, thiocarboxylic acids, thiosalicylic acids, and mixtures thereof, and (iv) a polishing pad and/or an abrasive.
2. The system of claim 1, wherein the liquid carrier is a nonaqueous solvent.
3. The system of claim 1, wherein the liquid carrier is water.
4. The system of claim 3, wherein the system comprises an abrasive suspended in the liquid carrier.
5. The system of claim 3, wherein the abrasive is fixed on the polishing pad.
6. The system of claim 3, wherein no abrasive is present in the system, and the polishing pad is a non-abrasive pad.

7. The system of claim 3, wherein at least one polishing additive is selected from the group consisting of di-phosphonic acids, tri-phosphonic acids, poly-phosphonic acids, phosphonoacetic acids, and mixtures thereof.

8. The system of claim 7, wherein at least one oxidizing agent is a peroxide, and wherein the system further comprises at least one passivation film forming agent comprising one or more 5-6 member heterocyclic nitrogen-containing rings.

9. The system of claim 7, wherein at least one polishing additive is selected from the group consisting of ethylene di-phosphonic acid, 1-hydroxyethylidene-1,1-di-phosphonic acid, and a mixture thereof.

10. The system of claim 3, wherein at least one polishing additive is selected from the group consisting of primary amines, secondary amines, tertiary amines, hydroxylated amines, and mixtures thereof.

11. The system of claim 10, wherein at least one polishing additive comprises the structure  $XY-NCR^1R^2CR^3R^4N-X'Y'$ , wherein X, Y, X', Y',  $R^1$ ,  $R^2$ ,  $R^3$ , and  $R^4$  are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups,  $C_1$ - $C_{20}$  alkyl groups, heteroatom-containing  $C_1$ - $C_{20}$  alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof.

12. The system of claim 11, wherein at least one polishing additive comprises the structure  $XY-NCR_1R_2CR_3R_4N-X'Y'$ , wherein X and X' are H atoms, and wherein Y, Y',  $R^1$ ,  $R^2$ ,  $R^3$ , and  $R^4$  are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof.

13. The system of claim 12, wherein at least one polishing additive comprises the structure  $XY-NCR^1R^2CR^3R^4N-X'Y'$ , wherein X, Y, X', and Y' are H atoms, and wherein  $R^1$ ,  $R^2$ ,  $R^3$ , and  $R^4$  are selected from the group consisting of hydrogen (H) atoms, heteroatom-containing functional groups, alkyl groups, heteroatom-containing alkyl groups, cyclic groups, heteroatom-containing cyclic groups, aromatic groups, heteroatom-containing aromatic groups, and combinations thereof.

14. The system of claim 11, wherein at least one polishing additive is selected from the group consisting of aminoethylethanolamine, polyethyleneimine, and a mixture thereof.

15. The system of claim 12, wherein at least one polishing additive is ethylenediamine.

16. The system of claim 13, wherein at least one oxidizing agent is a peroxide, and wherein the system further comprises at least one passivation film forming agent comprising one or more 5-6 member heterocyclic nitrogen-containing rings.

17. The system of claim 3, wherein at least one polishing additive is both (a) a compound selected from the group consisting of pyrophosphates, condensed phosphates, phosphonic acids and salts thereof, and (b) a compound selected from the group consisting of amines, amino alcohols, amides, imines, imino acids, nitriles, and nitros.

18. The system of claim 3, wherein at least one polishing additive is both (a) a compound selected from the group consisting of amines, amino alcohols, amides, imines, imino acids, nitriles, and nitros, and (b) a compound selected from the group consisting of thiols, thioesters, and thioethers, carbothiolic acids, carbothionic acids, thiocarboxylic acids, and thiosalicylic acids.

19. The system of claim 17, wherein at least one polishing additive is selected from the group consisting of 2-aminoethyl phosphonic acid, amino(trimethylenephosphonic acid), diethylenetriaminepenta(methylenephosphonic acid), hexamethylenediaminetetra(methylene phosphonic acid), and mixtures thereof.

20. The system of claim 3, wherein the system further comprises a source of ammonia.

21. The system of claim 20, wherein the system comprises (i) aminotri-(methylenephosphonic acid) and (ii) ammonia or an ammonium salt.

22. The system of claim 3, wherein the system further comprises at least one stopping compound.

23. The system of claim 3, wherein the system further comprises at least one polymeric compound that reduces the polishing rate of at least one layer associated with the substrate.

24. The system of claim 3, wherein the system further comprises at least one passivation film-forming agent.

25. The system of claim 3, wherein the abrasive is a metal oxide abrasive.

26. The system of claim 25, wherein the abrasive is selected from the group consisting of alumina, ceria, germania, silica, titania, zirconia, and coformed products thereof, and mixtures thereof.

27. The system of claim 26, wherein the abrasive is alumina.

32. The system of claim 1, wherein at least one polishing additive is iminodiacetic acid.

33. The system of claim 32, wherein the system further comprises at least one stopping compound.

34. The system of claim 32, wherein the system further comprises at least one polymeric compound that reduces the polishing rate of at least one layer associated with the substrate.

35. The system of claim 22, wherein the system further comprises ammonia or an ammonium salt.

36. A method of polishing one or more layers of a multi-layer substrate that includes a first noble metal layer and a second layer comprising:

- (i) contacting the substrate with a chemical-mechanical polishing system comprising:
  - (a) a liquid carrier,
  - (b) at least one oxidizing agent,

- (c) at least one polishing additive that increases the rate at which the system polishes the noble metal layer of the substrate, wherein the polishing additive is selected from the group consisting of carboxylates and acids thereof, hydroxylates and acids thereof, carbonylates and acids thereof, pyrophosphates, condensed phosphates, phosphonic acids and salts thereof, amines, amino alcohols, amides, imines, imino acids and salts thereof, nitriles, nitros, thiols, thioesters, thioethers, carbothiolic acids and salts thereof, carbothionic acids and salts thereof, thiocarboxylic acids and salts thereof, sulfonic acids and salts thereof, thiosalicylic acids and salts thereof, and mixtures thereof, and
- (d) a polishing pad and/or an abrasive, and
- (ii) abrading at least a portion of the substrate to polish the substrate.

37. The method of claim 36, wherein the oxidizing agent is a per-compound.

38. The method of claim 36, wherein the noble metal is platinum, iridium, or ruthenium.

39. The method of claim 38, wherein the polishing additive is selected from the group consisting of oxalate salts, pyrophosphate salts, aminotri(methylenephosphonic acid), 1-diphosphonic acid, diethylenetriaminepenta(methylenephosphonic acid), amino acids, and thiodiacetic acid.